



Faculty of Engineering

CSE115: Digital Design

**Lecture 4:
Coding**

Suggested Reading

- Sections 2.10-2.12

Coding

- **Coding:** Representing a set of objects by a set of strings.
- **Code:** The set of bit strings.
- **Code Word:** A particular bit string in the **Code**.

Examples:

- **Data Objects:** Decimal Numbers, Characters.
- **Nondata Objects:** Machine states, Control Actions.

Binary Codes For Decimal Numbers

- To represent the 10 decimal digits, we need 4 bits.

Examples:

– 4 bits Codes

1. BCD (8421) - Binary Coded Decimal
2. 2421
3. Excess-3

Decimal Codes

Decimal	BCD (8421)	BCD 2421	Excess-3
0	0000	0000	0011
1	0001	0001	0100
2	0010	0010	0101
3	0011	0011	0110
4	0100	0100	0111
5	0101	1011	1000
6	0110	1100	1001
7	0111	1101	1010
8	1000	1110	1011
9	1001	1111	1100

Exercise

- Codes for **517**

BCD: 0101 0001 0111

2421: 1011 0001 1101

Excess-3: 1000 0100 1010

Gray Code

One bit changes between two successive code words

Binary Code and Gray Code (n = 3):

Decimal	Binary Code	Gray Code
0	000	000
1	001	001
2	010	011
3	011	010
4	100	110
5	101	111
6	110	101
7	111	100

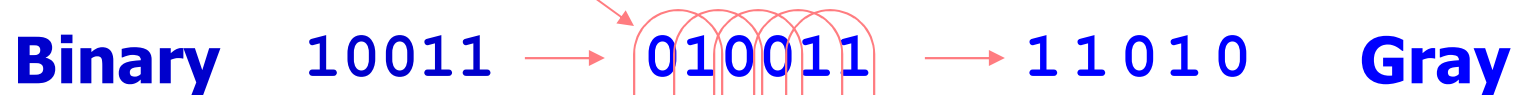
Application: Electromechanical applications.

The Mechanical Encoding disk. Altimeters.

Binary Code to Gray Code Conversion

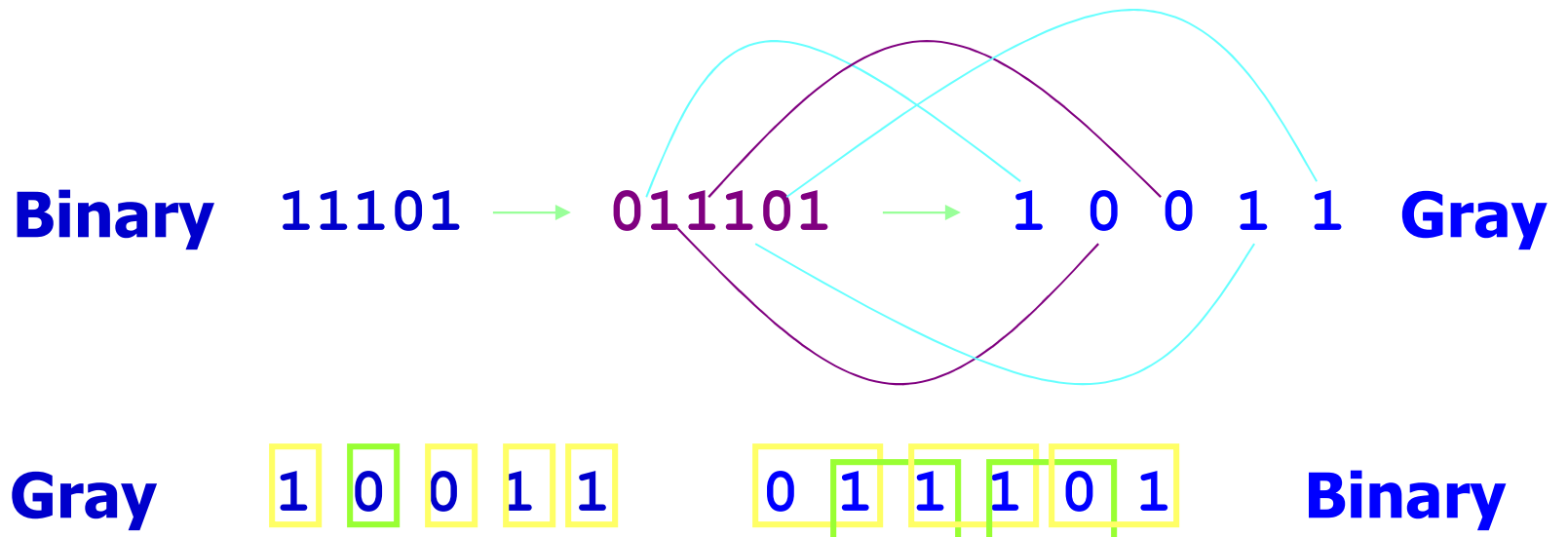
- Convert **n** bit Binary code into **n** bit Gray Code:
- Bit **i** of the Gray Code is obtained by comparing bits **i** and **i+1** of the Binary Code:
 - Add extra 0 to the left of the Binary code
 - If bits **i** and **i+1** in the Binary code are **the same** then bit **i** of the Gray code is **0**, else bit **i** is 1.
- Example:

Binary 10011 → **010011** → **11010** **Gray**



Exercise

i and i+1: **same** → **0**; else, **1**



Character Codes

- Each character is represented by a bit string
- **ASCII** - the American Standard Code for Information Interchange.
- Characters are encoded into **7** bits strings
- Contains **128** characters:
 - uppercase and lowercase letters
 - Numbers
 - punctuation marks
 - control characters

ASCII Table

		b6b5b4				b3b2b1b0			
		000	001	010	011	100	101	110	111
	0000			SP	0	@		'	
	0001			!	1	A		a	
	0010			"	2	B		b	
	0011			#	3	C		c	
	1111								

- The Code for a is **1100001**